STUDENT AWARDS

Quality in parking

PERFORMANCE PREDICTION

Student information
Author: Mateusz Wiza
Institution Maastricht University
Graduation year: 2021

Parking facility performance prediction using multi-target conformal regression

This thesis proposes a multi-target conformal regression approach for estimating the performance of new parking facility locations to be acquired by Q-Park.

Such forecasts should eliminate the need for consultancy reports prior to the development, sale or lease of new car parks: the basic parameters can be inserted into the algorithm and the artificial intelligence does the rest.

The basic data for the *machine learning model* include the capacity of the new car park, other car parks within a 1 km radius and their capacity, the presence of a train station within 500m and the numbers of offices, shops, hotels, restaurants and bars, educational institutions, industry and other buildings within 350m derived from OpenStreetMaps. Data relating to the floor space of shops, numbers of rooms in hotels and the like was not available for this research.

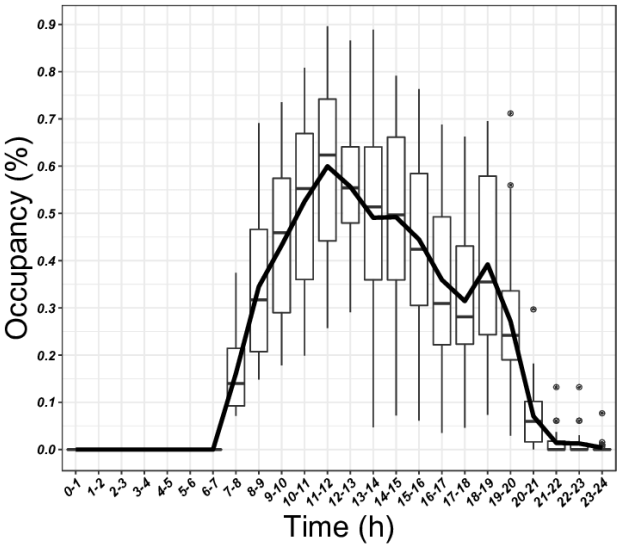
Data was collected for 1,037 existing Q-Park parking facilities in seven different countries. For these car parks, data including the number of hours parked, access and exit times, average length of stay, average occupancy and parking turnover per day were entered into the system. In addition, distinctions were made per country.

Various artificial intelligence techniques were applied to this database to identify which self-learning computational method best approximates the data imported. During the study, a prediction technology emerged which gave the best results. However, further research with more deep learning would be valuable.

Furthermore, additional more detailed basic data, such as shop floor area, numbers of workstations in offices, and numbers of hotel rooms, as well as results from existing car parks would make the artificial intelligence results even more reliable.

The thesis identifies the configuration of the regression model best suited for the task and compares the performance of different combinations of single and multi-target regression and conformal prediction. It also suggests the conformal method resulting in the most informative prediction regions.

Figure 1: Hourly evolution of parking occupancy for 30 regions (%). The line graph indicates the mean value of occupancy for all regions.



SHARED MOBILITY HUBS

Student information
Author: Rik van den Bogaerdt
Institution: Delft University of Technology
Graduation year: 2023

Shared mobility has found its way into the urban landscape over the last decade. Studies increasingly point to mobility hubs as a means of providing shared mobility options, usually run by actors within the mobility sector. However, shared mobility hubs have not been extensively studied from an urban development perspective.

This research examines the integration of shared mobility hubs into urban developments, and assesses how developers can manage this integration in both the development and functional phases, with a focus on so-called neighbourhood hubs.

Desk research was conducted to gain insight into current thinking on mobility hubs. This revealed that mobility hubs often encompass more than just mobility. Characteristics of mobility hubs include:

- connected to physical and digital networks;
- embedded in the urban fabric;
- focus on people and/or goods;
- cluster of facilities and functions, including shared mobility.

The desk research was followed by three case studies. Each involved plans for mobility hubs in different contexts. The semi-structured interviews explored the experiences of stakeholders in collaborating and guiding the integration of shared mobility hubs into urban development.

For example, the city of Rotterdam, where one of the case studies was based, would like to see a citywide network of hubs. There would be some common services and other offerings depending on the location and size of the hub.

The key takeaways can be summarised under two subtopics:

- **mobility hub concepts**: design and adaptability, digital integration and mobility as a service (MaaS), users and behaviour, including demand, transport modalities and operations, and energy;
- **urban development organisations**: organisation and management, business case, business-to-customer (B2C), parking.

Municipalities and developers have different perspectives and different objectives for mobility hubs, which are clearly reflected in the level of initiative taken by each. Possible explanations for these differences could be related to the municipality's level of experience with mobility hubs, differences in the political approach to mobility, housing demand, the existing infrastructure and public transport, and the size of the development.

Developers need to be aware that there's no fixed blueprint for a mobility hub that can be implemented in the same way everywhere. Smart hubs include a range of services in addition to mobility. Recommendations for developers working on mobility hubs include:

- guide the integration of shared mobility hubs into the urban environment by identifying the needs of the neighbourhood and the objectives of the developer;
- clearly define the purpose of the mobility hub and the products and services it will offer to residents and visitors.